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**Chen et al.**

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(54) **FREQUENCY AND AMPLITUDE  
STABILIZATION IN MEMS AND NEMS  
OSCILLATORS**

USPC ..... 74/490.1, 490.09; 330/137; 331/154, 96,  
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See application file for complete search history.

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(57) **ABSTRACT**

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(52) **U.S. Cl.**

CPC ..... **H03B 5/30** (2013.01); **B81B 7/02**  
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This invention comprises a nonlinear micro- and nano-mechanical resonator that can maintain frequency of operation and amplitude of operation for a period of time after all external power has been removed from the device. Utilizing specific nonlinear dynamics of the micromechanical resonator, mechanical energy at low frequencies can be input and stored in higher frequencies modes, thus using the multiple degrees of freedom of the resonator to extend its energy storage capacity. Furthermore, the energy stored in multiple vibrational modes can be used to maintain the resonator oscillating for a fixed period of time, even without an external power supply. This is the first demonstration of an “autonomous” frequency source that can maintain a constant frequency and vibrating amplitude when no external power is provided, making it ideal for applications requiring an oscillator in low power, or limited and intermittent power supplies.

**20 Claims, 7 Drawing Sheets**

(58) **Field of Classification Search**

CPC ..... H03G 3/20; B81B 7/02

